T&E ITEMS 1-2
March 29, 2007
Worksession #3

Committee members should bring the large packet of attachments from the March 19 worksession.

MEMORANDUM

TO: Transportation and Environment Committee

FROM: MF Michael Faden, Senior Legislative Attorney
GO Glenn Orlin, Deputy Council Staff Director

SUBJECT: **Worksession #3**:
Bill 48-06, Streets and Roads – Comprehensive Revisions
Subdivision Regulation Amendment 06-04, Streets and Roads – Design Standards

This worksession will begin the review of the numeric values in Article 3 (the Road Construction Code) and in the revisions to Chapter 50, as well as other substantive revisions. This packet will address the values in the table and notes on ©44-46 (and several proposed revisions to it), the values for curb return (corner) radius at intersections, and the proposed sidewalk waiver on ©72. Another worksession has been scheduled for Tuesday, April 10 (in the afternoon after the Council's public hearings) to address standards for street trees and stormwater management, and any follow-up from this worksession.

1. Categories of standards. Bill 48-06 stratifies standards for the width of lanes and the radius of curb returns to be less in 'urban' areas than elsewhere (©44-46). The purpose is to slow speeds down in these 'urban' areas to be compatible with the moderate-to-heavy pedestrian activity there. The bill defines 'urban' areas as: the Growth Policy's 9 Metro Station Policy Areas; Town Center Policy Areas (of which the Growth Policy currently defines only one that is not within a municipality: the Germantown Town Center Policy Area); and any "other urban area expressly identified in a Council resolution …" (©44, lines 1127-1128). The overview of the bills suggested that examples of other such 'urban' areas include: Montgomery Hills, Olney Town Center, and Clarksburg Town Center.

The Council would not identify these areas now. The adopted bill would not identify these other 'urban' areas; they would be identified as part of a separate Council resolution—presumably after the Council has held a public hearing on it—following adoption of the bill. In fact, if the bill is adopted before this summer, we suggest that the Planning Board's proposed 'other urban areas' be transmitted concurrently with its recommended update to the Growth Policy. The public could testify on the list of 'other urban areas' at the same time as the

Council's Growth Policy hearing in June, and the final resolution could be adopted by the Council concurrently with the Growth Policy resolution later in the summer.

The Planning Board recommends stratifying the 'other' areas of the County into 'suburban' and 'rural' areas, with differing standards in each. The rationale is that there are distinct differences in pedestrian activity between these two areas which should be reflected in the standards. The Planning Board's recommendation is that the boundary between the 'suburban' and 'rural' area be the Priority Funding Area (PFA) boundary (see ©198).

We agree that the bill should be amended to include separate standards for each road classification in 'urban,' 'suburban,' and 'rural' areas. However, we recommend that the boundary between 'rural' and 'suburban' areas be the boundary in the Growth Policy between the Rural Policy Areas and the other policy areas (©199). This boundary is less jagged and more coherent than the PFA boundary, and planners and engineers are more familiar with the Growth Policy geography. This boundary is a bit more expansive than the PFA boundary, so more roadway miles would come under the 'suburban' standard if it were used.

We recommend that where a road is the boundary between the 'urban' and 'suburban' area, the 'urban' standards apply to the entire right-of-way of the road. Similarly, where a road is the boundary between the 'suburban' and 'rural' area, the 'suburban' standards apply.

2. Revised set of standards. Based on the comments received in testimony, correspondence, and further conversations with staffs and interested citizens, we are recommending several changes to ©44-47, which contains the numeric values for standards. **Our revised table of standards and the associates notes are on ©200-202.**

a. Target speed. As recommended by the Planning Board, we now recommend that each road classification, by area, have a unique 'target' speed: the maximum speed at which most drivers will feel comfortable driving, given all aspects the roadway's design: horizontal and vertical curvature, sight distance, lane width, horizontal obstructions (e.g., curbs, placement of street trees), etc.

We recommend setting target speeds of 20 mph or 25 mph for every street in an 'urban' area (depending on the classification), and 15 mph for alleys. These are speeds that are compatible with the moderate-to-heavy pedestrian activity that exists or is ultimately anticipated in the county's 'urban' areas. **Secondary and tertiary residential streets would have target speeds of 20 mph** (which is also the speed that a car can comfortably pass over a regular speed hump) **and Primary Residential Streets would have a target speed of 25 mph. Higher classifications would have progressively higher target speeds, and, within the same classification, the target speed in the 'rural' areas often would be higher than in the 'suburban' area.**

b. Lane width. Responding to the Planning Board's recommendation, **we now propose reducing the lane-widths of non-residential streets in 'urban' areas by a further 0.5': the**

lane-widths would generally be 10'; the exceptions would be Major Highways and Parkways, which would have lane widths of 10.5'. Examples of existing Major Highways with lanes about 10' or less in width are:

Wisconsin Avenue: Friendship Heights to Bradley Boulevard
Wisconsin Avenue: East-West Highway to Battery Place
Colesville Road: Georgia Avenue to Dale Drive
Connecticut Avenue: Chevy Chase Circle to East-West Highway

Many others have lane-widths of about 10.5'. The predominant lane widths for Major Highways and Arterials are 11' or 12'. The bill's proposed lane widths would generally result in no more than 1' per lane difference (if any) to roads outside 'urban' areas.

Several bike groups and individual bikers objected to the bill's providing only 1' more for a shared-use roadway—formerly known as a Class III Bikeway—where motor vehicles and bicycles are generally expected to travel next to each other. They advocated that the curb lane be widened to 14' where a shared-use roadway is proposed. **We now propose that in 'suburban' and 'rural' areas that 2' be added to the curb lane where a shared-use roadway is consistent with the master plan.** This means that where the Code otherwise calls for 12' lanes, that the curb lane would be 14' wide (plus 1' for the gutter), where it calls for 11' lanes, the curb lane would be 13' wide, etc. In 'urban' areas, however, the sum of the road design elements will produce a slow enough speed so that bikers be able to ride safely in front and behind motor vehicles, and not need to ride to the outside of them.

Another concern of the bikers was the bill's proposed widths for paved shoulders on open-section roadways, as bikers often use the shoulders where speeds are high and there is not a designated bike lane. The bill proposed 4' paved shoulders for Major Highways and 2' paved shoulders for other classifications, in order to reduce potential imperviousness and to discourage excessive motor vehicle speed. **We now propose, for open-section roadways, 5' paved shoulders for Controlled Major Highways and Major Highways, and 4' paved shoulders for Country Arterials, Arterials, and Minor Arterials.** The stormwater from the wider paved cross-sections can be managed with sufficient bio-retention measures. Other techniques can be employed to mitigate potential speeding, such as adding a tactile differentiation in the lane marking separating the outside lane from the shoulder.

c. Curbside width. **We agree with the Planning Board to add 'curbside width' to the table.** Curbside width is the area beyond each curb necessary for sidewalks, shared use paths, street trees and other landscaping, streetlights, utilities, and other elements. The Planning staff proposes that this area generally extend 15' beyond the edge of the curb to accommodate these elements. For open-section roads and streets, this area is more variable because of the need to provide swales, so in those cases the standards should be determined in the design standards approved by Executive regulation.

d. Bike lane width. Bill 48-06 calls for master-planned bike lanes to be 5' wide on Controlled Major Highways, Major Highways, Country Arterials, and Arterials, 4' wide on

Minor Arterials, and 3' wide on Primary Residential Streets. **We now propose that master-planned bike lanes on Arterials in 'urban' and 'suburban' areas be 4' wide, and be 5' wide in 'rural' areas only.** The 4' width is more commensurate with the target speed and traffic volume on Arterials. **Country Arterials should have a bike lane width of 4' to reflecting the purpose of this classification, which is to preserve as much of the rural ambience as possible.**

e. Sidewalk width. The Planning staff has pointed out that sidewalks in 'urban' areas are very wide, and that the 5+' notation does not provide much guidance. Therefore, **we now recommend that sidewalks in 'urban' areas be at least 15' wide on Major Highways and at least 10' wide on Arterials. We also recommend that all streets that have a Primary Residential Street or higher classification have 5'-wide sidewalks.**

However, we continue to recommend that Secondary and Tertiary Residential Streets have 4'-wide sidewalks. This is wide enough to comfortably accommodate the relatively small number of pedestrians walking along these streets. In the rare case where two baby carriages or wheelchairs pass each other, one can yield to the other—which is exactly the mode of behavior expected of drivers on Secondary and Tertiary Residential Streets.

f. Curb return (corner) radius. Section 49-32(c) calls for a maximum 15'-wide curb return radius for intersections in 'urban' areas, with appropriate adjustments to allow fire and rescue vehicles to negotiate such a tight corner. The bill calls for a maximum 25' radius elsewhere (©47, lines 1166-1171).

We now recommend deleting Section 49-32(c) from the bill. We still believe the size of the curb return radius is extraordinarily important in determining pedestrian safety at an intersection, and it is imperative that this standard be reduced explicitly in the design standards to be produced in the Executive regulation. However, a lot of interlocking factors contribute to the determination of the proper curb return radius (see ©203-212) and it would be too simplistic to reduce the direction in law to only two standards.

3. Sidewalk waiver. The current law allows the Director of Permitting Services to waive the requirement to build sidewalks if the lots abutting the right-of-way are unimproved or if the terrain is such that a sidewalk can be built only at an "excessive" cost or are otherwise undesirable (©71, lines 1810-1823). The Director may even deny this waiver, however, if the sidewalk would be along a Primary Residential Street or higher classified road, or if the sidewalk is "necessary or desirable to provide safe access for pedestrians" (©71-72, lines 1824-1835).

Periodically a subdivision is built along a section of road where the required sidewalk would connect to nothing else—not to a school, a bus stop, or even another sidewalk—which is not uncommon for subdivisions in semi-rural and rural areas of the county. The result can be a rather useless 'improvement' that also incurs County cost to maintain and the requirement by fronting residents to clear snow. In such cases, the bill proposes that the Director of Permitting Services be empowered to waive the requirement in exchange for the builder: (1) dedicating the necessary right-of-way and easements to allow the sidewalk to be built in the future; and (2) paying a fee equal to the design, construction, and construction management costs of the sidewalk. The proceeds from these fees would be assigned to a capital account for new sidewalk construction, and spent if the Council were to appropriate the funds (presumably in addition to the G.O. Bond-funded expenditures in the Capital Improvements Program's Annual Sidewalk Program, or some other individual sidewalk project in the CIP).

The Executive's comments are as follows:

> Allowing a developer to pay a fee in lieu of constructing sidewalk should only be done as a last resort, and only after considerable proof of hardship to be approved by the County Executive or designee. This philosophy is in keeping with the County's goals of creating walkable communities and ensuring pedestrian safety. The cost basis for the fee should reflect the timing of the future construction. (©153)

We agree that this provision would be used infrequently, but that the degree that it is used would provide more funds for sidewalks that are needed in the short term.

However, we do not agree that cost basis for the fee should reflect the timing of future construction. If the funds would essentially be shifted from one sidewalk to be built now to another (more needed) sidewalk to be built now, how does a *future* cost figure into the equation? And how could a future cost be calculated?

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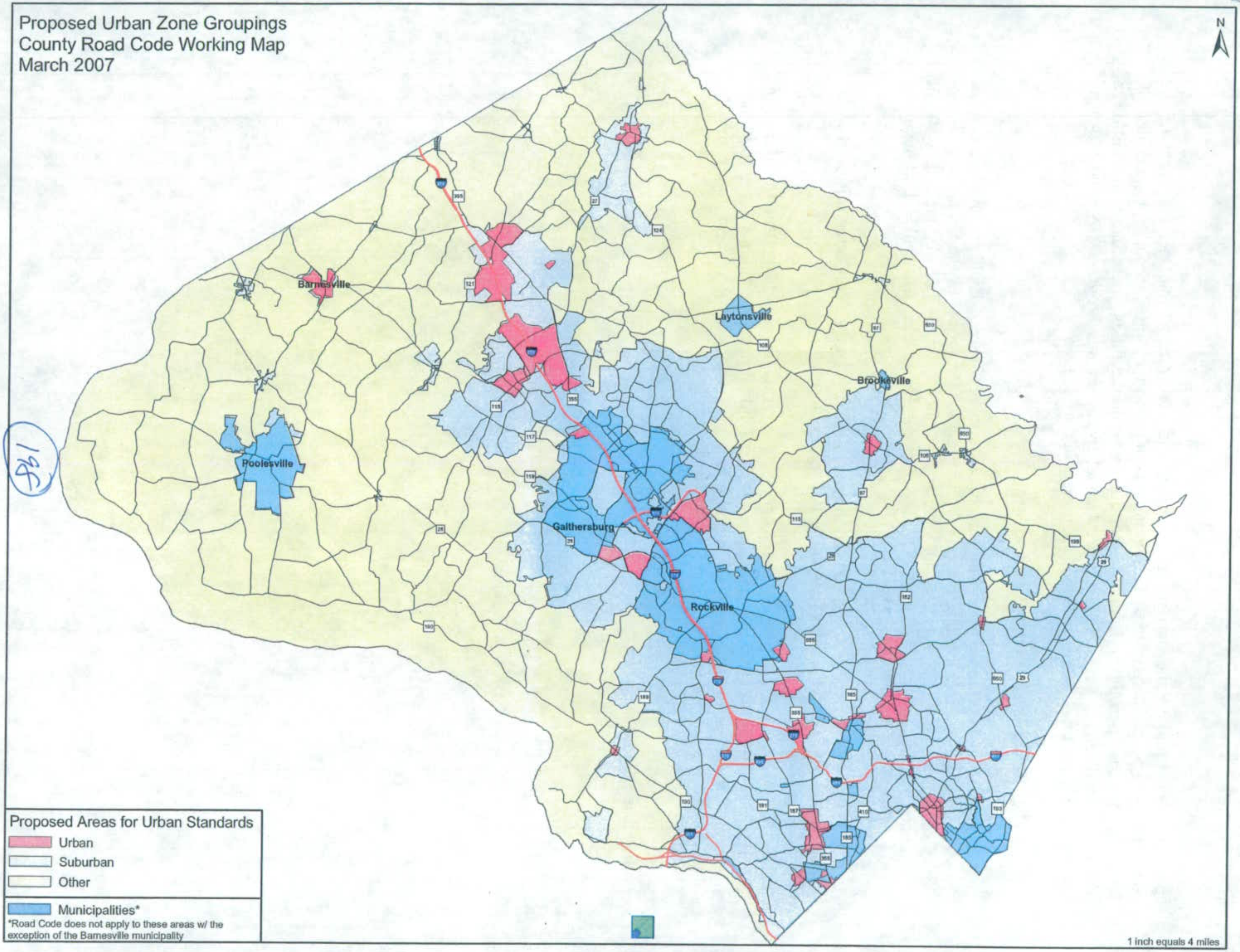
Proposed Urban Zone Groupings
County Road Code Working Map
March 2007



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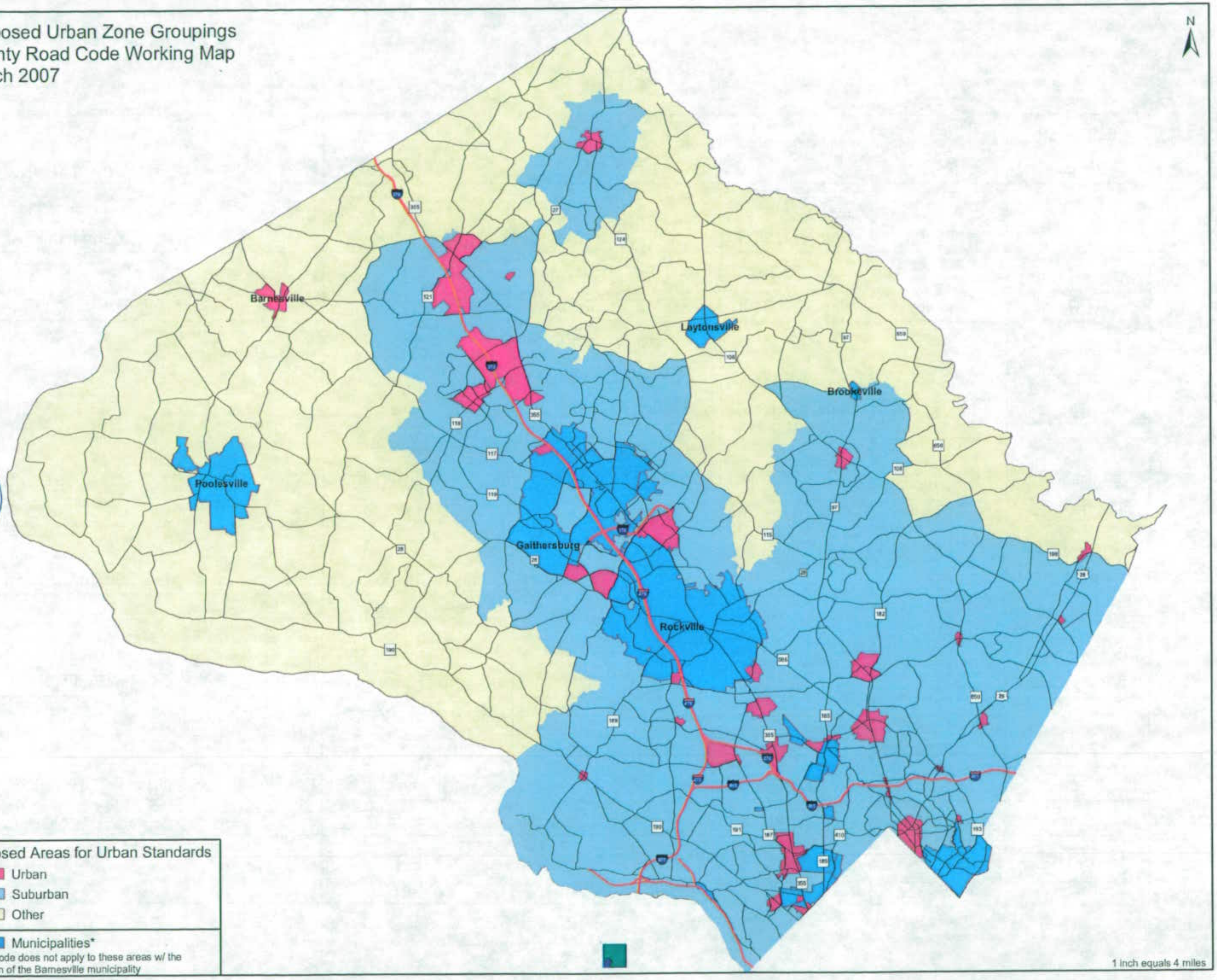
Proposed Urban Zone Groupings
County Road Code Working Map
March 2007



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Classification	Target Speed	Road/Lane Width	Curbside Width[6]	Bike Lane Width[2]	Sidewalk Width[8]
Freeway	55 mph	12' lanes	Variable	none	none
Controlled Major Highway[1]	50 mph	12' lanes	Variable	5'	5'
Parkway[1]	urban: 25 mph suburban: 35 mph	11' lanes	25'	none	none
Major Highway[1,3]	urban: 25 mph suburban: 35-40 mph rural: 45 mph[7]	urban: 10.5' lanes suburban: 11' lanes rural: 12' lanes	urban: 20' min. elsewhere: 15'	5'	urban: 15' min. elsewhere: 5'
Country Arterial[4]	suburban: 40 mph rural: 45 mph[7]	11' lanes		4'	suburban: 5' rural: none
Arterial[1,4]	urban: 25 mph suburban: 35 mph rural: 40 mph[7]	urban: 10' lanes suburban: 11' lanes rural: 12' lanes	urban: 15' min. elsewhere: 15'	urban: 4' suburban: 4' rural: 5'	urban: 10' min. elsewhere: 5'
Minor Arterial[1,4]	urban: 25 mph suburban: 30 mph rural: 35 mph[7]	urban: 10' lanes suburban: 10.5' lanes rural: 11' lanes	urban: 15' min. elsewhere: 15'	4'	5'
Business District Street[1]	urban: 20 mph elsewhere: 25 mph	urban: 10' lanes elsewhere: 11' lanes	urban: 15' min. elsewhere: 15'	none	10'
Industrial Street[1]	urban: 20 mph elsewhere: 25 mph	urban: 10' lanes elsewhere: 11' lanes	urban: 15' min. elsewhere: 15'	none	5'
Country Road	25 mph	20' road		none	suburban: 5' rural: none

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Classification	***Target Speed***	***Road/Lane Width***	***Curbside Width***[6]	***Bike Lane Width***[2]	***Sidewalk Width***[8]
Primary and Principal Secondary Residential Streets	25 mph		15’	3’	5’
(no curbs or parking)		20’ road			
(w/curbs, no parking)[5]		22’ road			
(w/curbs, 1-side parking)[5]		28’ road			
(w/curbs, 2-side parking)[5]		34’ road			
Secondary Residential Street	20 mph		15’	none	4’
(no curbs, no parking)		20’ road			
(w/curbs, no parking)		20’ road			
(w/curbs, 1-side parking)		20’ road			
(w/curbs, 2-side parking)		24’ road			
Tertiary Residential Street	20 mph	20’ road	12’	None	4’
Alley	15 mph	urban (2-way): 20’ road urban (1-way): 16’ road suburban: 16’ road	None	None	none

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Notes

(1) Add 1 foot of width to each lane abutting an outside curb. Except in urban areas, add another 2 feet of width to each lane abutting an outside curb if a shared-use roadway is consistent with the Countywide Bikeways Functional Master Plan or the applicable area master or sector plan.

(2) Bike lanes must be included when a road is constructed or reconstructed if bike lanes are consistent with the Countywide Bikeways Functional Master Plan or the applicable area master or sector plan. This bike lane width replaces the added width under note (1).

(3) For an open-section Controlled Major Highway, Major Highway or Country Arterial add 5 feet of width on each road edge for a paved shoulder. A bike lane replaces this additional width.

(4) For an open-section Arterial or Minor Arterial add 4 feet of width beyond the edge of the outside lane for a paved shoulder. If a bike lane is provided on a road edge, the bike lane replaces this additional width.

(5) For a Primary or Principal Secondary Residential Street, the total curb-to-curb width must be the sum of the road width and any master-planned bike lane widths.

(6) Curbside width is the area beyond each curb necessary for sidewalks, shared use paths, street trees and other landscaping, streetlights, utilities, and other elements. For open section roads and streets, the area beyond the shoulder is shown in the design standards approved by Executive regulation under Section 49-1(b).

(7) Target speed for these classifications in rural commercial zones is 30 mph.

(8) Sidewalks are required on both sides of roads and streets except for Secondary and Tertiary Residential Streets, where the Planning Board may require a sidewalk on either one or both sides of a street, depending on the housing density and potential use of sidewalks. Alleys must not have sidewalks.

Curb Return Radii

Background and Purpose

> **Related Thoroughfare Design Elements**
> - *Selecting the design vehicle*
> - *Speed*
> - *On-street parking*
> - *Right-turn channelization*
> - *Pedestrian refuge islands*

Curb returns are the curved connection of curbs in the corners formed by the intersection of two streets. A curb return's purpose is to guide vehicles in turning corners and separate vehicular traffic from pedestrian areas at intersection corners. The radius of the curve varies, with longer radii used to facilitate the turning of large trucks and buses. Larger radius corners increase the length of pedestrian crosswalks.

In CSS, the smallest practical curb return radii are used to shorten the length of the pedestrian crosswalks. Based on this function, this report suggests a general strategy for selecting curb return radii design criteria and discusses situations requiring larger design vehicles.

General Principles and Considerations

General principles and considerations regarding curb return radii include the following.

- Curb return radii should be designed to accommodate the largest vehicle type that will frequently turn the corner (sometimes referred to as the control vehicle). This principle assumes that the occasional large vehicle can encroach into the opposing travel lane as shown in Figure 10.7. If encroachment is not acceptable, then a larger design vehicle should be used.
- Curb return radii should be designed to reflect the "effective" turning radius of the corner. The effective turning radius takes into account the wheel tracking of the design vehicle utilizing the width of parking and bicycle lanes. Use of the effective turning radii allows a smaller curb return radius while retaining the ability to accommodate larger design vehicles (Figure 10.8).

Effect of Curb Radii on Pedestrian Crossing Distance (Compared to 15 ft. Radius)

Curb Return Radius (Feet)	Added Crossing Distance (Feet)	Added Crossing Time (Seconds) [1]
15	0	0
25	8	2
50	38	10

[1] Crossing time at 4 ft. per second.

- In urban centers (C-5) and urban cores (C-6) where pedestrian activity is intensive, curb return radii should be as small as possible.
- On multi-lane thoroughfares, large vehicles may encroach entirely into the adjacent travel lanes (in the same direction of travel).
- To help select a design vehicle, identify bus routes to determine whether buses are required to turn at the intersection. Also check transit service plans for anticipated future transit routes. Map existing and potential future land uses along both streets to evaluate potential truck trips turning at the intersection.
- Apply curb return radii that are compatible with the design vehicle. Occasional turns by vehicles that are larger than the design vehicle could be accomplished by turning more slowly and possibly encroaching into oncoming travel lanes to complete the turn.
- Curb return radii of different lengths can be used on different corners of the same intersection to match the design vehicle turning at that corner. Compound, spiral, or asymmetrical curb returns can be used to better match the wheel tracking of the design vehicle (see AASHTO's Green Book for the design of spiral and compound curves).
- If large vehicles need to encroach into an opposing travel lane, consider placing the stop line for opposing traffic further from the intersection.

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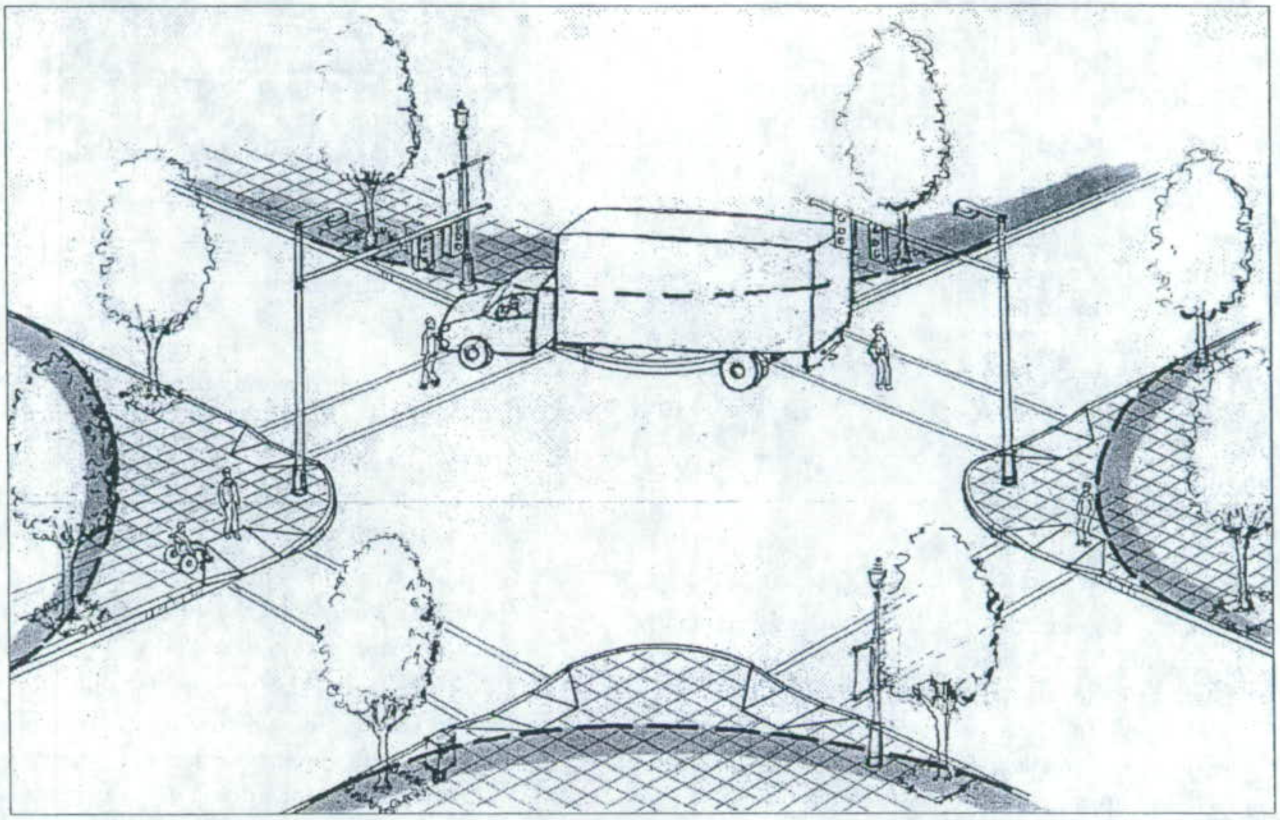

Figure 10.7 Smaller curb return radii shorten the distance that pedestrians must cross at intersections. The occasional turn made by large trucks can be accommodated with slower speeds and some encroachment into the opposing traffic lanes. Source: Kimley-Horn and Associates Inc.

Recommended Practice

Flexibility in the design of curb return revolves around: (1) choice of design vehicle, (2) combination of dimensions that make up the effective width of the approach and receiving lanes and (3) the curb return radius itself. The practitioner needs to consider the trade-offs between the traffic safety and operational effects of infrequent large vehicles and the creation of a street crossing that appears reasonable to pedestrians. The guidelines assume arterial and collector streets in urban contexts (C-3 to C-6) with turning speeds of city buses and large trucks of 5 to 10 mph. The guidance is not applicable to intersections without curbs.

Recommended practices include the following.

- In urban centers (C-5) and urban cores (C-6) at intersections with no vehicle turns, the minimum curb return radii should be 5 ft.
- A typical minimum curb return radius of 10 to 15 ft. should be used where:

1. High pedestrian volumes are present or reasonably anticipated;
2. Volumes of turning vehicles are low;
3. The width of the receiving intersection approach can accommodate a turning passenger vehicle without encroachment into the opposing lane;
4. Passenger vehicles constitute the majority of turning vehicles;
5. Bicycle and parking lanes create additional space to accommodate the "effective" turning radius of vehicles;
6. Low turning speeds are required or desired; and
7. Occasional encroachment of turning school bus, moving van, fire truck, or oversized delivery truck into an opposing lane is acceptable.

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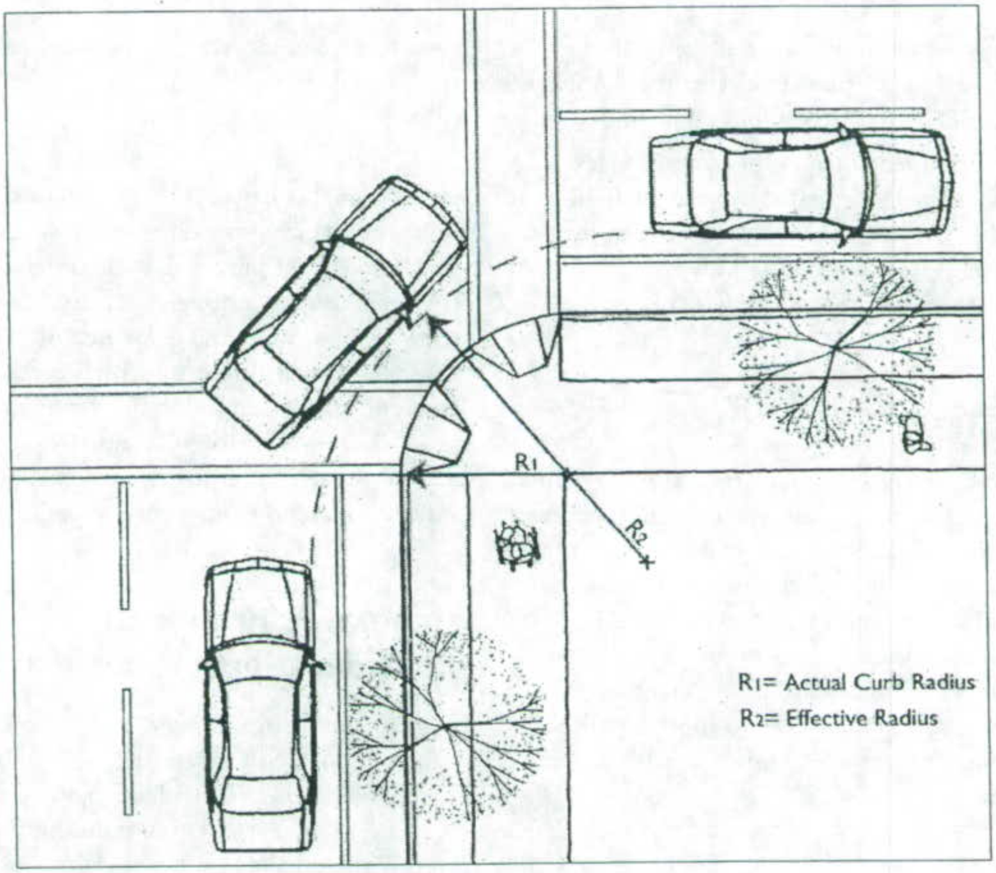

Figure 10.8 The existence of parking and bicycle lanes creates an "effective" turning radius that is greater than the curb return radius. Source: Community, Design + Architecture, adapted from the *Oregon Bicycle and Pedestrian Plan*.

- Curb radii will need to be larger where:
  1. Occasional encroachment of a turning bus, school bus, moving van, fire truck, or over-sized delivery truck into the opposing lane is not acceptable;
  2. Curb extensions are proposed or might be added in the future; and
  3. Receiving thoroughfare does not have parking or bicycle lanes and the receiving lane is less than 12 ft. in width.

Recommendations for Curb Radii on Transit and Freight Routes

Trucks routes should be designated on a minimum number of appropriately selected streets to reduce the impact of large turning radii on pedestrian routes. Where designated local or regional truck routes conflict with high pedestrian volumes or activities, analyze freight movement needs and consider re-designation of local and regional truck routes to minimize such conflicts.

On bus and truck routes, the following guidelines should be considered.

- Curb return radii design should be based on the effective turning radius of the prevailing design vehicle.
- Where the potential for conflicts with pedestrians is high and large vehicle turning movements necessitate curb radii exceeding 50 ft., evaluate installation of a channelized right-turn lane with a pedestrian refuge island (see the section on pedestrian refuge islands in Chapter 9 and the section on channelized right-turn lanes in Chapter 10). To better accommodate the path of large

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vehicles use a three-centered compound curve in the design of the island (see the AASHTO Green Book's Chapter 9 for design guidance).

- Where frequent turning of large vehicles takes place, avoid inadequate curb return radii as it could potentially cause large vehicles to regularly travel across the curb and into the pedestrian waiting area of the roadside.

Justification

Intersections designed for the largest turning vehicle traveling at significant speeds with no encroachment results in long pedestrian crossings and potentially high-conflict areas for pedestrians and bicyclists. Radii designed to accommodate the occasional large vehicle will allow passenger cars to turn at high speeds. In CSS, the selection of curb returns ranging from 5 to 25 ft. in radius is preferable to shorten pedestrian crossings and slow vehicle turning speeds to increase safety for all users.

Channelized Right-Turns

Background and Purpose

Related Thoroughfare Design Elements:

- *Curb return radii*
- *Crosswalks*
- *Bicycle lanes at intersections*

In urban contexts, high-speed channelized right turns are often inappropriate because they create conflicts with pedestrians. Under some circumstances, providing channelized right-turn lanes on one or more approaches at a signalized intersection can be beneficial, but unless designed correctly, these right-turn lanes can be undesirable for pedestrians. According to the *Oregon Bicycle and Pedestrian Plan* a well-designed channelization island can:

- Allow pedestrians to cross fewer lanes at a time and judge conflicts separately;
- Provide refuge for slower pedestrians;
- Improve accessibility to pedestrian push-buttons; and
- Reduce total crossing distance, which provides signal-timing benefits.

Right-turning drivers may not have to stop for the traffic signal when a poorly designed channelized right-turn lane is provided. Even where pedestrian signal heads are provided at the intersection, pedestrians are usually expected to cross-channelized right-turn lanes without the assistance of a traffic signal. Most channelized right-turn lanes consist of only one lane and the crossing distance tends to be relatively short. However, drivers are usually looking to their left to merge into cross-street traffic and are not always attentive to the presence of pedestrians.

General Principles and Considerations

The general principles and considerations regarding channelized right turns include the following.

- Avoid using channelized right-turn lanes where pedestrian activity is significant. If a channelized right-turn lane is unavoidable, use design techniques described to lessen the impact on pedestrians.
- Exclusive right-turn lanes should be limited. A right-turning volume threshold of 200–300 vehicles per hour is an acceptable range for the provision of right-turn lanes. Once determined that a right-turn lane is necessary, a well-designed channelization island can help slow down traffic and separate conflicts between right-turning vehicles and pedestrians (Figure 10.9).
- If an urban channelized right-turn lane is justified, design it for low speeds (5 to 10 mph) and high-pedestrian visibility.
- For signalized intersections with significant pedestrian activity, it is highly desirable to have pedestrians cross fully under signal control. This minimizes vehicle-pedestrian conflicts and adds to the comfort of pedestrians walking in the area.
- Consider channelized right-turn lanes at multilane all-way stop controlled intersections to provide pedestrians an additional refuge among the complex right-of-way patterns that affect traffic movements.

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Connecting Charlotte

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Appendix D: Curb Return Radii Design Guidelines

I. Overview and Purpose

The intent of the curb return radii design guidelines is to establish a procedure that allows flexibility in designing curb radii to reflect conditions of specific locations, while assuring that the *result will yield the smallest radii that are feasible* to accommodate the specified design vehicle.

The primary reason for minimizing curb radii is to help provide shorter crossings for pedestrians. In general, the distance a pedestrian must cross to reach the opposite curb will decrease as the curb radius decreases. Similarly, the larger the radius, the greater the distance the pedestrian has to traverse and the more the pedestrian is potentially out of the line-of-sight of the driver. Smaller radii can also serve as a traffic calming design feature, requiring vehicles to turn at slower speeds, depending on the width of the street.

Smaller curb radii, therefore, serve to:

- Minimize the (unprotected) distance pedestrians need to cross,
- Allow for better alignment of the crosswalk with the connecting sidewalks (i.e., provide a continuous path of travel),
- Assure adequate space at the corner for proper placement and alignment of ADA-compliant curb ramps (typically, one per each direction of travel is desired),
- Moderate the speeds of turning vehicles,
- Improve visibility of drivers and pedestrians,
- Result in improved compliance with "No Turn On Red" regulations.

While the overall intent is to keep radii small and improve pedestrian crossings, curb radii will be designed to accommodate the expected type and volume of vehicle turning at the intersection. Properly designed curb radii will provide sufficient space for the expected vehicles to maneuver through their turns safely, while minimizing conflicts between cars, trucks, buses, bicyclists and pedestrians. The design should also take into account the typology of the two intersecting streets, the level of pedestrian activity expected, the location of crosswalks, curb ramps, presence or absence of bike lanes, pedestrian refuge islands, curb extensions, bus stops and on-street parking, and whether the intersection is signalized or unsignalized.

II. Design Criteria

The following guidelines are to be used to determine the curb radii at any given intersection. For the purposes of this process, the AASHTO Green Book's "crawl speeds" are assumed for the turning speeds of vehicles.

It is important to note that, as with any document of this nature, these guidelines are intended to provide guidance and direction when designing streets and should be flexible to account for the specific traffic, vehicle and roadway conditions at any given location, and be sensitive to any unique or unusual situations. Sound engineering and planning judgment shall be used to produce designs in keeping with the context of the adjacent land uses and surrounding street network.

Approach

The approach outlined in this section is different for ***Local*** and ***Non-Local*** streets, given the different nature and context of each of these typologies. The discussion on *Non-Local* streets is presented first as this is typically the more complex of the two street types.

a) Non-Local Streets

Determination of Appropriate Design Vehicle

The appropriate curb radii to be used at the intersection of two non-local streets is initially based on the type and frequency of vehicle (the "design vehicle") expected to traverse the intersection under normal conditions. While often not readily available, this information can be determined by a variety of methods, such as field observations, vehicle classification counts, and assumptions and projections based on future land uses.

In the absence of specific information regarding the types and numbers of vehicles expected, Table 1 shall be used to select the appropriate design vehicle:

Table 1 – Design Vehicle for Non-Local Street Intersections

	Local	Main	Avenue	Boulevard	Parkway
Local	See Table4	Pass. Veh.	School Bus	SU-30	B-40
Main	-	SU-30	SU-30	B-40	B-40
Avenue	-	-	B-40	B-40	WB-50
Boulevard	-	-	-	WB-50	WB-50
Parkway	-	-	-	-	WB-62

Potential Encroachment for Turning Vehicles

Once a design vehicle is selected, the designer must make assumptions regarding the potential encroachment into various travel lanes on the receiving street. These assumptions relate to the ability of the design vehicle to turn from one street into the available traffic lanes on the receiving street. The possible encroachment is based on a number of factors, including the street typology, the number and width of traffic lanes, available sight distance, the speed and volume of vehicles on each street and the presence or absence of onstreet parking. As a result, different curb radii may be designed for each corner of an intersection.

While it is acknowledged that occasional encroachment by larger vehicles into adjacent or opposing lanes of traffic will occur, the goal is to minimize as much as possible conflicts between vehicles, pedestrians, bicyclists, and other users of the street, while providing the minimum curb radii appropriate for the given situation.

Tables 2 and **3** are to be used as a guide to determine the potential/possible encroachment for vehicles turning at signalized and unsignalized intersections, given the factors described above. **Figure 1** graphically illustrates the various encroachment scenarios ("cases" shown in **Tables 2** and **3**) that may be used for the design vehicle in determining the appropriate curb radii.

Table 2 – Allowable Encroachment for Signalized Intersections

From\To*	Local	Main	Avenue	Boulevard	Parkway
Local	Table 4	Case B	Case B	Case B	Case B
Main	Case D	Case C	Case B**	Case B	Case B
Avenue	Case D	Case C	Case B**	Case B	Case B
Boulevard	Case C	Case C	Case B**	Case B	Case B
Parkway	Case C	Case C	Case B**	Case B	Case B

Table 3 – Allowable Encroachment for Unsignalized Intersections

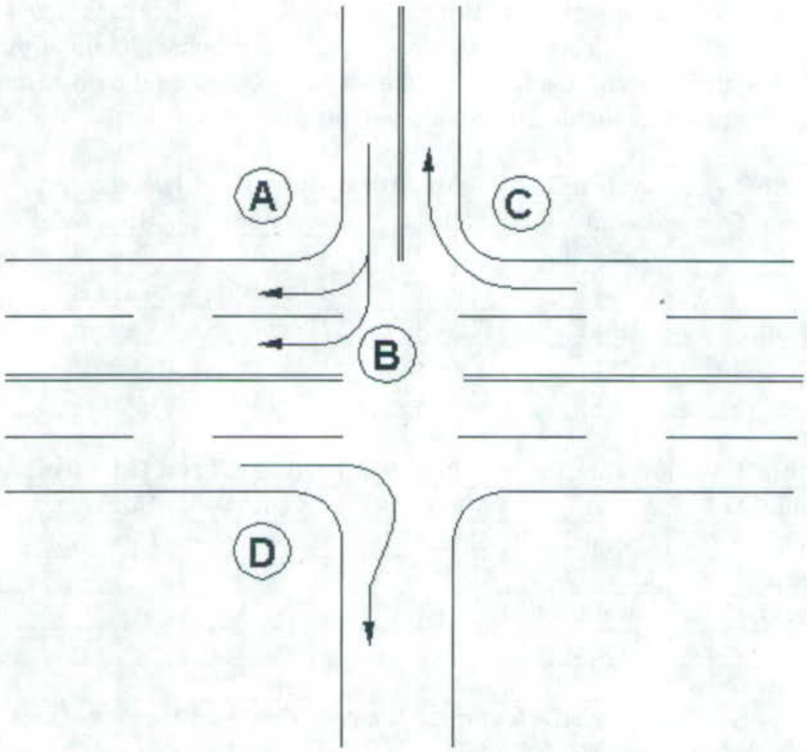
From\To*	Local	Main	Avenue	Boulevard	Parkway
Local	Table 4	Case C	Case A	Case A	-
Main	Case D	Case C	-	-	-
Avenue	Case D	-	-	-	-
Boulevard	Case D	-	-	-	-
Parkway	-	-	-	-	-

*The column along the left side of the table indicates the street ***from*** which the vehicle is turning; the headings indicate the ***receiving*** street.

**Case B should be assumed, unless the Avenue only has one receiving lane, whereupon Case A should be assumed.

The possible encroachment is intended to be more flexible at signalized intersections (i.e., resulting in smaller radii), since it is assumed that a) larger vehicles can wait for a green signal to assure adequate space to safely complete their turn, and b) a higher level of pedestrian activity is expected or desired.

FIGURE 1
ENCROACHMENT FOR INTERSECTIONS
USE IN CONJUNCTION WITH TABLES 2 AND 3
(NOT TO SCALE)



LETTER CORRESPONDS TO CASE LISTED IN TABLES 2 AND 3

NOTE: LANE WIDTHS ARE NOT CONSIDERED

b) Local Streets

As stated previously, determination of the appropriate curb radii is based on many factors. In the case of *Local Streets*, curb-to-curb width must also be considered. In most cases, the width of the street is the critical factor in determining the necessary curb radii for *Local Streets*.

While *Local Streets* are typically narrower than *Non-Local Streets*, there is also more flexibility in applying the design vehicle encroachment guidelines, since it is generally assumed that the full width of available pavement can be used to "receive" the turning vehicle. This, of course, must take into account the traffic volumes, function, adjacent land uses and specific conditions of the street being designed.

Table 4 indicates the curb radii to be used for the intersections of *Local Streets*. Again, while the goal is to provide the smallest radii possible, the design should be tested to be sure it can adequately accommodate the *expected* typical design vehicle, based on the specific traffic and roadway conditions of the project area.

Table 4 - Curb Radii for Local Street Intersections

From\To	R/Narrow	R/Medium	R/Wide	C/Narrow	C/Wide	Industrial
R/Narrow	35					
R/Medium	20	15				
R/Wide	15	15	10			
C/Narrow	20	15	25	35		
C/Wide	15	15	15	30	10	
Industrial	30	25	15	40	25	50

R = Residential
C = Commercial

III. Other Factors Affecting Curb Radii

As previously stated, the determination of the appropriate curb radii for any given location is influenced by many different and varied factors. For the purpose of achieving the goals of Charlotte's *Urban Street Design Guidelines*, the overwhelming consideration for most street types is for safety, including providing safer and shorter pedestrian crossings.

While minimizing the curb radii is the desired outcome, other factors must be evaluated to assure that the design is adequate before a final determination can be made.

Additional factors to consider include:

- *The overall street pattern* – depending on the size and layout of the adjacent street system, it may be appropriate to design smaller radii at most intersections (e.g. along a *Main Street*), while accommodating larger vehicles at fewer select locations along designated routes.
- *The presence of a bike lane* – the additional width created by a bike lane makes the effective curb radius larger. Therefore, the actual curb radius can usually be smaller when a bike lane exists.
- *The presence of a raised median or pedestrian refuge island* - may require larger radii to prevent vehicles from encroaching onto the median. Alternatively, particularly for "gateway" medians on Local Streets, medians may have aprons to allow larger vehicles to turn without damaging landscaping or curbs.
- *Skewed or oddly shaped intersections* - may dictate larger or smaller radii than the guidelines would otherwise indicate.
- *Lane configuration or traffic flow* – intersections of one-way streets, locations where certain movements are prohibited (left or right turns), or streets with uneven numbers of lanes (two in one direction, one in the other) will also affect the design of curb radii.
- *Onstreet Parking* – the presence or absence of onstreet parking will directly affect the curb radii required to accommodate the design vehicle. **Table 5** may be used where *permanent full-time* onstreet parking is allowed and accommodated on *both streets* at an intersection.

Table 5 – Curb Radii with Permanent Full-time Onstreet Parking*

From\To	Local	Main	Avenue	Boulevard	Parkway
Local	15	20	25	30	-
Main	20	20	25	30	-
Avenue	25	25	25	30	-
Boulevard	30	30	30	35	-
Parkway	-	-	-	-	-

* *This table should not be used where parking is either part-time only or occurs infrequently.*

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